

ABSTRACT OF THE DISCLOSURE

An apparatus includes a planar substrate and an array of substantially transparent spherical micro-lenses forming a pattern. The pattern has an internal two-dimensional lattice symmetry on the planar substrate. Each micro-lens includes a
5 convex bulge or a concave depression in a surface of the planar substrate. The micro-lenses and substrate include hydrogel that swells and contracts in a manner that is responsive to an environmental condition.